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BLACK COAL IN AUSTRALIA

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INTRODUCTION

Coal was first discovered in Australia in 1791 by an escaped convict near the site of Newcastle. This discovery was followed in 1793 by a report of coal at South Cape, Tasmania: 32 years later, in 1825, black coal was discovered near Wonthaggi, Victoria and in 1824 outcrops were found in the Ipswich district of Queensland. Discoveries at Irwin River, Western Australia and Leigh Creek, South Australia were made in 1846 and 1888, respectively.

EXPLORATION AND DEVELOPMENT

New South Wales

Mining began in 1799 with the collection of coal from outcrops near Newcastle for sale in Sydney, and the first export of Australian coal took place in 1801 when 150 tonnes of Newcastle coal was despatched to India.

Although coal was first discovered very early in the colony's settlement, no attempt at systematic investigation of coal resources was made for 75 years.

From about 1867, government geologists showed increasing interest in coal, and many geological investigations and drilling programs were undertaken. Increasing demand for coal by a growing steel industry and for the production of town gas in the early years of the twentieth century created further interest in exploration, particularly by companies.

A sharp brake was applied to the industry with the onset of the depression in the 1930s and it was not until after World War II that renewed interest was shown in coal as an energy form.

In the late 1940s and early 1950s a vigorous exploration program was undertaken by the Joint Coal Board with additional investigations by BMR and the Geological Survey of New South Wales. Exploration ration received a boost in 1957 when the Electricity Commission of New South Wales began exploration ration and development of coal deposits. Companies had continued active exploration during the 1950s with emphasis on supplying the steel industry's

coal requirements.

The most important factor in exploration and development in recent years was the advent of a growing export market in the 1960s and 1970s. Exploration philosophies changed in this time attention was turned toward proving reserves in areas known to contain coal and in districts already producing coal. The Geological Survey and the Joint Coal Board concentrated efforts in areas outside allotted exploration leases and colliery holdings, while companies were responsible for exploration within lease boundaries.

Queensland

Although the initial discovery of coal was made in 1824 at lpswich, the first true mining venture did not commence until 1846 at a location between lpswich and Brisbane.

Following the discovery of coal at Blair Athol in 1846, interest in exploration grew steadily and government geologists in the latter part of the century concentrated activity in the Bowen Basin of Central Queensland. These investigations mainly took the form of mapping and interpretation of the geology; some drilling was done in the northern Bowen Basin in 1885, but it was only partly successful in delineating new coal reserves.

At the turn of the century attention focused on the Blackwater district where considerable drilling programs were undertaken by the Mammoth Coal Company and the Mount Morgan Gold Mining Co.

The depression years seriously restricted both exploration and mine development and although there were some small developments it was not until the early 1960s that the industry commenced a period of growth, which has continued to the present. As in New South Wales, it was assisted by the rapid growth in export markets, but Queensland coal producers with a limited domestic market and no local steel industry still are heavily dependent on export sales.

Exploration grew rapidly in the late 1950s and has Continued at a high rate to the present. The early stages of this exploration resulted in the establishment of mines at Callide, Moura, Kianga, and Black-water. Subsequent investigations led to the establishment of mines at Goonyella, Peak Downs, and Saraji; more recently, Gregory and Norwich Park mines have come into production.

Queensland coal exploration is now carried out in a pattern very similar to that in New South Wales: the Geological Survey of the Department of Mines undertakes investigations outside allotted exploration leases and colliery holdings, while companies continue exploration within lease boundaries.

Victoria

Black coal was first discovered at Cape Preston in 1825, but it was not until 1908 that drilling by the Department of Mines outlined a deposit at Wonthaggi on which a State coal mine was established.

The competition from brown coal caused a strong shift away from the use of Black coal and in 1968 the State mine closed. Smaller mines established at Wonthaggi had closed years before. There are now no operating black coal mines in Victoria.

Tasmania

The first report of coal in Tasmania was in 1793 at South Cape. In the succeeding decades small occurrences were discovered in many places on the east coast and in northern districts, but the most important coalfield was discovered in 1886 at Mount Nicholas.

Mining of coal in the State began near Port Arthur in 1834 but this operation ceased when the penal colony was abandoned in 1877. Although many small operations commenced in the late 1800s and early 1900s only The Cornwall Coal Company's operation near Fingal, which was established soon after the discovery of the Mount Nicholas Field in 1886, has survived.

Scope for development and growth of coal mining in Tasmania has always been restricted because most of the State's electricity is provided by hydro-electric schemes, leaving only relatively small Industrial trial consumers, and for some time railways, to maintain a demand for coal.

South Australia

Black coal was discovered at Leigh Creek in 1888. A shaft was sunk at the site in I 892, but the coal proved to be unsatisfactory for use in railway locomotives and the shaft was abandoned A further attempt to mine the coal was undertaken in 1906 but it too was abandoned. It was not until 1944, after a series of detailed investigations, that mining began at the Telford open cut at Leigh Creek. The coal was once used by the railways and industry as well as for electricity generation, but now the entire production is consumed at the Port Augusta power station. In 1948 the mining operations came under the control of the Electricity Trust of South Australia.

Exploration in recent years has resulted in discoveries of large but low-quality deposits in the Arckaringa Basin to the west of Lake Eyre.

Western Australia

Black coal was discovered in Western Australia in 1846 at Irwin River southeast of Geraldton, and in 1883 the important Collie deposits were found.

Investigation of the Collie field commenced almost immediately and culminated in the establishment of a mine in 1898. After World War II a systematic survey of the Collie field was undertaken by the Geological Survey of Western Australia with assistance from BMR. This survey delineated the boundary of the deposits and allowed estimates of the reserves to be made.

Coal from Collie was originally used mainly in the State's rail system and to a lesser extent for electricity generation. The development of alumina projects in Western Australia has created a demand for coal, through increased power requirements. which has more than offset that lost as the railways converted to liquid fuel.

Exploration is continuing in various areas of the State, particular interest being shown in the prospective areas around Derby and Eneabba.

Current position

Black coal is mined today in every Australian State except Victoria and the Northern Territory, and exploration is being undertaken in all the States by companies, and in most States by government bodies. Research into the geology, exploration, mining, preparation, and use of coal is funded both by industry and government. Funding by the Federal Government is by way of grants from the National Energy Research Development & Demonstration Council.

Exploration is largely in the hands of private enterprise and almost $47 million was spent by companies in 1979–80 in the search for coal. Of this, Just over half was spent in Queensland and 30 per cent in New South Wales. Expenditure in 1979–80 was almost twice that of the previous year and almost four times that in 1976–77, indicating the great resurgence of interest in coal as

an energy source in recent years. Of the $47 million spent on exploration in 1979–80 only $6 million was spent within the boundaries of existing production leases.

TABLE 1. AUSTRALIAN COAL MINES, 30 JUNE 1980

	N.S.W	Qld	S.A.	W.A.	Tas.	Total
Open-cut	13	19	1	2	. .	35
Underground	70	26	. .	1	1	98

(**Source**:Joint Coal Board)

The Joint Coal Board (1981) reported that, at the end of June 1980, there were 133 operational coalmines in Australia distributed as shown above. Of the 133 mines, 98 were underground and 35 open-cut mines. The location of mining areas is shown in Plate 39.

The importance of open-cut mining to the industry is well illustrated by the fact that in 1980 five open-cut mines produced 19.0 million tonnes (Mt) of saleable coal or almost 25 percent of total Australian production. The remaining 1 28 mines produced a total of 57.3 Mt. It is expected that this trend will be further accentuated when large open-cut mines like Gregory and Norwich Park work up to full capacity.

The five mines referred to are the Goonyella (3.6 Mt saleable coal in 1980), Peak Downs (3.7 Mt), and Saraji (3.9 Mt) operations of Central Queensland Coal Associates (CQCA), the Blackwater mine (3.8 Mt) of Utah Development Co. in Queensland, and the Ravensworth mine (4.0 Mt) operated by Costain Australia Ltd for the Electricity Commission of Ness South Wales.

Underground mines were the dominant producers of coal until 1974, when, for the first time, almost half the annual production of raw coal was from open-cut mines. Although the proportion of coal won by open-cut methods had been rising for many years a sharp increase occurred in 1972, as new mines in Queensland came on stream and worked up to full capacity. In that year an extra 10.5 Mt of open-cut coal was produced and the open-cut share of production rose from 30 to 40 percent. A similar but smaller increase in open-cut production and a reduction in underground production in 1974 increased the open-cut share of production to almost 50 percent. Since 1975, the relative proportions of underground and open-cut have stabilised. remaining steady at a little more than half for open-cut coal.

Over the last decade New South Wales, Queensland, and Western Australia have produced coal from both underground and open-cut mines. In New South Wales most coal has traditionally come from underground mines and that situation still prevails, although on a raw-coal basis their contribution has fallen from 92 percent in 1970 to 72 percent in 1980. In Queensland the reverse applies:

open-cut production has been dominant and is becoming increasingly so. The proportion of total pro production won by open-cut mining in Queensland has risen from 70 percent in 1970 to 88 percent in 1980. A similar situation prevails in Western Australia where the proportion of production supplied from open-cut mines rose from 61 percent in 1970 to 80 percent in 1980.

The ability of the Australian coal industry to increase coal production in response to increasing demand was based largely on the following factors: the advent and growth of open-cut mines, the advent of mechanised mining, particularly in underground operations, and the existence of large unexploited resources.

Mining methods

Coal mining in Australia was essentially a manual operation until the mid-1930s. Most early mines were dug into coal seams from surface exposures, the coal being recovered by pick and shovel. The coal won was carried or pushed in trolleys to the surface, or to the bottom of a vertical shaft or inclined shaft and then hoisted to the surface. Some burden on the miners was removed with the introduction of pit ponies to haul coal.

Historically most of Australia's coal production has come from underground mines. From pick and shovel operations of limited production, these mines have been transformed by mechanisation to highly sophisticated operations capable of high rates of production. The most important development in underground mining has been the advent of machines for continuous and longwall mining.

Most underground coalmines in Australia use variations of the bord-and-pillar system of mining which, although theoretically capable of recovering all the coal, in practice usually recovers only about 60 percent. Continuous-mining machines are used in the bord-and-pillar system to break and extract coal from the working face, which is about 10 m wide, and load it into shuttle cars for transport.

Longwall mining is not widely used in Australia but its use is expected to increase. While it may be possible to achieve 100 percent coal recovery by longwall techniques it is generally considered that, with good mining conditions, a maximum recovery rate is about 90 percent. The longwall miner shears coal onto a conveyor from a working face 100-200 m wide.

One of the main advantages of the longwall system therefore is that it allows greater recovery than the bord-and-pillar system. To achieve maximum benefit from a longwall unit the coal seam should be of uniform thickness and not have any geological discontinuities, e.g. faults, or intrusions. Continuous miners, on the other hand, are able to mine coal more efficiently from seams affected by such discontinuities.

The introduction of high-capacity mechanised mining has meant that all material in the coal seam at the working face is mined. Consequently any stonebands or other impurities are mined along with the coal. Because it is usually not possible to separate such impurities at the working face, they must be removed later if the coal is to meet specifications.

Coal as mined is referred to as 'raw coal'. Raw coal is crushed and usually washed to remove the impurities. The largest coal preparation plants currently in use are able to process up to 2000 tonnes/hour. The Joint Coal Board reported that at the end of June 1980. coal producers in New South Wales were operating 35 washeries and that two additional plants were in operation at Port Kembla and Newcastle steelworks. In 1979 in Queensland 9 washeries serviced underground mines and 9 open cuts. The only other washery in Australia is a small plant servicing the Duncan mine in Tasmania. Once the coal has been crushed and washed the upgraded product is referred to as saleable coal.

Employment

The black coal industry has always been a large employer, but the level of employment compared to production reflects the impact mechanisation has had on the industry.

In 930 there was an average of 27,528 people employed in the black coal industry and production was slightly more than 9.5 Mt. By the end of 1980 employment was 27,591, yet production of raw coal for 1980 had risen to 93.4 Mt.

Employment levels in the industry have undergone several long-term fluctuations over the last fifty years, in response to a variety of social, economic, and technological pressures. From the

high level in 930 the Great Depression resulted in numbers falling to slightly less than 21,000 in 1931 and to 17,687 by 1935. From just before to just after World War lithe increased demand for coal raised employment to a stable level of about 22,300.

In the late 1940s and the first half of the 1950s the demand for coal continued to rise in response to the post-war reconstruction and development boom. Employment in the industry grew strongly as a consequence, peaking at 27,135 at the end of December 1952 and 27,028 in June 1954.

By 1956 the first impact of oil as a substitute for coal was being felt. Production of coal stagnated in the late 1950s and grew only slowly in the first half of the 1960s. The effect of this slackening in demand and the progress made in mechanisation of mines was dramatic. Employment fell below 20,000 and for most of the 1960s was around 15,000 to 16,000.

The first three years of the 1970s saw some increase, with employment rates of about 18,500. The remainder of the 1970s saw a steady growth in employment. Perhaps the most important factor in bringing on this changed position was the increasing demand for coking coal by the Japanese steel in industry. Although the demand for coking coal slackened, the impact of oil crisis of 1973 and the sub subsequent uncertainty of supplies resulted in renewed demand for thermal coal, which has ensured steady growth in employment.

Production, exports, and consumption

A statistical summary of Australian black coal production and trade since 1951 is given in the following Table 2 and Plate 40.

From 1799, when mining first began, to the end of 1980, over 1,963 Mt of coal was won. Despite some short-term setbacks, as occurred during the depression years of the 1930s, production has increased steadily.

Black coal production statistics are presented as tonnes of raw coal and tonnes of saleable coal.

Until 1949 raw and saleable coal were virtually the same, but social, economic, and technicality factors since then have resulted in a lowering of the proportion of saleable coal produced from raw coal.

Three distinct phases can be delineated in the production of raw coal since 1951; a slow increase from l951 to 1959 (average increase 0.34 Mt/year), a faster increase from 1960 to 1967 (1.67Mt/ year), and a still faster increase from 1968 to 1980 (3.91 Mt/year). The second and third phases both reflect increased demand from the international market. The corresponding growth figures for sailable coal are lower, reflecting the increased tonnage of mined coal being discarded as washery reject material The average growth was 0.22, 1.36, and 2.95 Mt/year for each phase. Strikes in 1980 ad adversely affected production; otherwise the third-phase averages would have been higher.

Accelerated growth of production in 1960–67 can be attributed to increased demand for coking coal from the Japanese steel industry, but for 1968–80 the situation is more complex. Until the early 1970s, increased demand for coking coal for steel production, particularly in Japan, continued to be the main factor. The effect of a faltering in the rate of growth of world steel production in the mid-1970s was offset by increasing demands for thermal coal and diversification of markets for coking coal. Demand for thermal coal was the direct result of the 1973 quadrupling of oil prices, causing many tries and energy-intensive industries to turn from oil to coal.

Exports of black coal have increased consistently from 1960 to the present. From 100,000 tonnes exported in 1951, exports grew slowly to 795,000 tonnes in 1959. For 1960 the figure was 1.6 Mt.

valued at $13 million, and for 1980 it was over 42 Mt, valued at $1,684 million. Although the relative importance of Japan as a market for Australian coal has declined in recent years, in 1980 that country still took over 69 percent (29.3 Mt) of the coal exported from Australia. The Republic of Korea and Taiwan Province were the next most important customers, taking 5.7 percent (2.5 Mt) and 4.4 percent (1.9 Mt) respectively.

Though the growth in Australia's consumption since 1962 has been consistent, it has not matched the growth in exports. Exports have increased to over 420 times their 1951 level, but domestic consumption has only doubled in the same period, rising from 17.6 Mt in 1951 to 36.4 Mt in 1980. It was not until 1973 that the tonnage exported surpassed the tonnage consumed in Australia.

The electricity-generating industry is by far the largest consumer of coal in Australia. In 1980 it accounted for 67 percent of all coal used whereas the iron and steel industry accounted for only 22 per cent. The equivalent figures for 1970 are: electricity generation 51 percent, and iron and steel industry 32 per cent. New South Wales, the major consuming State, used over 23 Mt (64 percent) of all coal consumed in Australia in 1980, most of it for electricity generation.

It is expected that domestic consumption will continue to increase, but the growth rate will be dependent to a large extent on developments in the aluminium-smelting and cokemaking industries.

TABLE 2. BLACK COAL IN AUSTRALIA: PRINCIPAL STATISTICS ('000 tones)

Year	Production		Saleable Raw (per cent)	Saleable domestic consumption	Exports	Imports	Stocks at years end
	Raw	Saleable					
1951	17,900	17,859	99.8	17,611	100	350	2,020
1952	19,720	19,665	99.7	17,896	205	283	3,869
1953	18,7I8	18,591	99.3	18,484	367	17	3,624
1954	20,069	19,835	98.8	19,240	364	3	3,859
1955	19,605	19,362	98.8	18,940	216	4	4,061
1956	19,578	19,322	98.7	18,773	282	5	4,346
1957	20,197	19,804	98.1	18,955	768	9	4,461
1958	20,852	20,140	96.6	18,807	822	6	4,971
1959	20,943	19,820	94.6	19,962	795	8	4,034
1960	23,350	21,917	93.9	20,107	1,602	5	4,233
1961	24,924	23,179	93.0	19,929	2,896	8	4,633
1962	25,374	23,501	92.6	20,210	2,956	7	4,922
1963	25,908	23,835	92.0	20,488	3,226	l0	5,028
1964	28,718	26,276	91.5	21,880	4,883	11	4,612
1965	32,944	30,086	91.3	22,811	7,271	11	4,803
1966	35,111	3I,657	90.2	22,504	8,373	13	5,307
1967	36,676	32,822	89.5	23,667	9,550	8	5,087
1968	42,568	37,917	89.1	24,429	12,291	9	5,995
1969	48,154	42,572	88.4	25,265	16,039	12	6,977
1970	52,350	45,407	86.7	25,141	18,296	10	8,847
1971	52,423	44,077	84.1	25,327	20,178	18	6,661
1972	65,537	54,647	83.4	26,608	23,511	9	10,834
1973	67,858	55,598	81.9	27,292	28,434	11	10,875
1974	70,435	57,943	82.3	29,019	29,440	15	10,454
1975	74,784	60,944	81.5	29,591	30,428	6	11,697

1976	84,224	68,198	81.0	31,327	32,917	11	14,037
1977	87,321	70,809	81.1	32,087	36,427	3	16,544
1978	89,345	71,831	80.4	32,967	38,095	23	16,830
1979	93,043	74,993	80.6	34,875	41,050	16	16,317
1980	93,406	76,304	81.7	36,381	42,284	2	13,623

Source: Joint Coal Board. Bureau of Mineral Resources.

Resources

Australia's demonstrated economic resources of black coal are 50.4 x $l0^9$ tonnes in situ. Of this total only 28.7 x $l0^9$ tonnes is regarded as being recoverable with currently available technology and prevailing economic and social constraints. Queensland and New South Wales together have over 98 percent of the country's in situ demonstrated economic resources. An outline of Australia's demonstrated economic resources is given in Table 3.

Resources currently less well known geologically ('inferred resources') total 477 x 10^9 tonnes, of which 273 x 10^9 tonnes is considered to be recoverable. Any coal deposit included in this category re quires further testing by drilling, etc., before it can be classified as a demonstrated resource.

As a result of renewed interest in coal as an energy source in recent years and the consequent in crease in exploration, the level of demonstrated economic resources has increased substantially. From 34.7 x $l0^9$ tonnes in 1975 it rose to 50.4 x $l0^9$ in 1980. It is relevant to note that this increase (15.7 x $l0^9$ tonnes) is 30 times larger than the total amount of coal mined in that period (0.522 x $l0^9$ tonnes).

TABLE 3. AUSTRALIAN DEMONSTRATED RESOURCES OF BLACK COAL (million tonnes)

		In situ	Recoverable
New South Wales	. . . . .	21,234	11,001
Sydney Basin	. . . . .	972	637
Gunnedah Basin	. . . . .	36	33
Gloucester Basin	. . . . .	500	450
Oaklands Basin	. . . . .	1	1
Ashford			
		22,743	12,122
Queensland	. . . . .	22,678	12,854
Bowen Basin	. . . . .	800	450
Galilee Basin	. . . . .	490	245
lpswich Basin	. . . . .	280	241
Tarong Basin	. . . . .	205	142
Callide Basin	. . . . .	15	7
Mulgildie Basin	. . . . .	2,428	2,118
Surat-Moreton Basin	. . . . .	4	2
Styx Basin			
		26,900	16,059

Western Australia	. . . . .	496	362
Collie	. . . . .	139	69
Tasmania	. . . . .	120	120
South Australia			
Grand total		**50,398**	**28,732**

Thus Australia's total demonstrated-plus-inferred resources are 527 x 10^9 tonnes, of which just over 9 percent is demonstrated. The fact that there is detailed information available on such a small proportion of Australia's resources suggests that it is most important that exploration continue at a rate at least equivalent to that achieved in recent years. This point becomes all the more significant when the projected growth in both exports and domestic consumption is considered.

Over half the currently known inferred resources are in the Sydney Basin; however, very little work has been done on the estimation of inferred resources outside New South Wales. Although no concerted attempt has been made to estimate Queensland's inferred resources it is most probable that they would at least equal those of New South Wales.

The Bowen and Sydney Basins are the main regions which inferred resources will be upgraded to demonstrated resources. There are, however, other regions in most States that have the potential to contain considerable tonnages of demonstrated resources. In Queensland. outside the basins from which coal is currently being mined, the most prospective area is the Galilee Basin. The Queensland Department of Mines (1981) reports the quantity of demonstrated resources in the Galilee Basin as 800 Mt, located near the township of Alpha. Substantial but unquantified resources occur in the basin several hundred kilometres further north near Hughenden. Despite the remoteness of the Galilee Basin in comparison with the Bowen Basin, future exploration will almost certainly add considerable tonnages to Australia's demonstrated economic resources.

In South Australia the most prospective area for increasing the level of demonstrated resources is the Arckaringa Basin, although it is unlikely that this coal will be economically recoverable in the near future. The Department of Mines & Energy (1980) reported demonstrated resources of 600 Mt, with considerably larger inferred resources. Continuing private exploration has suggested that substantial tonnages occur to the north of the presently known Lake Phillipson deposit.

Considerable exploration has been carried out in Western Australia, and the prospects for increasing the State's demonstrated resources are good. There is a strong possibility that any coal discovered in these areas may not be economically recoverable in the near future. Both the northern and southern parts of the Perth Basin appear to have good prospects for the proving of deposits. Encouraging inter sections of coal have been encountered in drillholes in the Canning Basin in the Derby region and further exploration could well delineate substantial deposits at these locations.

Coal occurrences are widespread in Tasmania, but in many areas of interest exploration and exploitation are hindered by the coal's being covered by hard igneous rocks. Recent exploration has indicated that the delineation of small but locally significant deposits will add considerably to Tasmania's demonstrated economic resources.

The areas discussed above are those considered most likely to have inferred resources upgraded to demonstrated economic or sub-economic resources in the next decade.

In addition to the demonstrated economic and inferred resources Australia has substantial but generally not well delineated resources of deeply buried coal. Included in this category is 130 x 10^9 tonnes in the Sydney Basin, and the South Australian Department of Mines & Energy (1980) have noted the presence of as much as 3000 x 10^9 tonnes between 1,400 and 4,000 m deep in the Cooper and Pedirka Basins. Although there is no prospect of these resources being utilised in the foreseeable future those in New South Wales may ultimately be recovered by underground mining. The deep resources in the Cooper and Pedirka Basins, towards the centre of the continent, will probably only ever be utilised if adequate technologies are developed for **in-situ** processing such as gasification.

Australia's coal industry in the world context

Australia was the world's ninth-largest producer of black coal in 1980, with about 3 percent of total world production of saleable coal. Of the coal traded internationally in 1980 Australia provided 42.3 Mt. making it the second-largest exporter after USA (Table 4).

Most of Australia's strength in the international coal trade is derived from its ability to produce far more coal than is required for domestic consumption. In 1980 Australia was able to export 55 percent of total saleable production. The only other country able to achieve a percentage close to this level was Canada with 49 percent, but it must be remembered that Canada also imports large tonnages of coal.

On estimates currently available Australia has 4 percent of the world's in-situ demonstrated economic resources and 6 percent of the world's recoverable demonstrated economic resources. However, very large inferred resources, which ultimately are likely to be economically mineable. are known to occur in both Queensland and New South Wales.

Technology

The increasing cost and potential shortage of petroleum will, in the future, result in greater demand for coal. Interest has been growing in the re-introduction of coal-fired ships in place of oil-fuelled ones. The first step in this direction has already been taken with an order for the construction of two coal-fired bulk carriers for use in the Australian coastal alumina trade.

TABLE 4. WORLD PRODUCTION AND EXPORTS OF BLACK COAL IN 1980

		Production (Mt. Saleable coal)	Exports (Mt)	Exports Production (percentage)
Australia	. . .	76.4	42.3	55
Canada	. . .	30.8	15.0	49
China	. . .	663.0	–	–
Germany, F.R	. . .	94.5	12.6	13
India	. . .	107.5	–	–
Poland	. . .	193.1	30.4	16
South Africa	. . .	115.1	29.2	25
UK	. . .	128.2	–	–
USA	. . .	723.6	82.3	11
USSR	. . .	519.0	n.a.	–
Australia's ranking	. . .	9	2	1

Expanded use of coal may also be expected in the manufacture of bricks and cement and in the fuel fuelling of boilers previously operated with oil.

Possibly the most important innovation will be the development of a commercially viable fluidised bed combustion system. This method of combustion can not only burn normal coal fuels efficiently but can also use lower-grade coals and much of the reject material discarded from coal washeries.

A very large additional tonnage of coal, both black and brown, will be required if commercial plants for converting coal to liquid fuels are set up in Australia. It has already been decided to establish pilot plants and undertake further feasibility studies of the production of liquid fuels from brown coal. Black coal is less certain to be used because it will face strong competition from oil shale as a source of liquid fuels.

The future

The Australian black coal industry is experiencing a period of sustained growth that appears certain to continue for many years. Stimulus for this growth is being provided by increasing demand for thermal coal from overseas buyers.

The actual level of production, consumption, and exports that will be achieved at any particular time in the future is arguable. Projections made by authoritative organisations usually differ, but they all agree that growth will be strong. A summary of some forecasts is given in the following table.

TABLE 5. FORECAST 1990 EXPORTS AND DOMESTIC CONSUMPTION OF AUSTRALIAN BLACK COAL (Mt)

	Exports			Domestic consumption		
	Thermal	Coking	Total	Thermal	Coking	Total
Department of National Development & Energy (1981)	70	60	130	–	–	–
	50-70	50-60	100-130	–	–	–
Department of Trade & Resources (1981)	42	68	110	64(c)	12(c)	76
World Coal Study (1980)	57-100	58-80	115-180	57.3-75.3	16.7-22.7	74-98
Joint Coal Board (1980) (*a*)	55	60	115	48	12	60
BMR(*b*)	8.9	23.3	42.2	28.1	8.2	36.3
Actual 1980						

(a) Joint Cost Board figures are estimates of demand rather than forecasts of actual exports or consumption.
(b) Refer to text for discussion of Bureau of Mineral Resources estimates.
(c) Estimates derived from World Coal Study (WOCOL) Report.

Exports

The BMR export projections have been made on the assumptions that markets will be available, that satisfactory prices will be negotiated, and that Australian infrastructure, availability of suitable personnel, and industrial relations will allow demand to be met. Although it is acknowledged that each of these factors may have a significant influence on the industry, it is not within the scope of this paper to discuss them; however, it is considered most likely that any difficulties that may

arise will be resolved without serious long-term impact on the industry.

BMR's estimates of thermal and coking coal exports are based on categorisation of product by potential producers. While this does not influence the total export projection it does introduce an uncertainty into the individual product estimates. In view of the prevailing conditions in the world steel industries and the increasing demand for thermal coal, it is expected that some poorer coking coals will in fact be exported as thermal coals. Projected export for 1990 are 66 Mt of nominal coking coal and 49 Mt of nominal thermal coal. It is considered that up to 6 Mt of coking coal may in fact be used as thermal coal in 1990, and the export estimates by BMR shown in the previous table have been adjusted accordingly.

Should the current world oil supply and price situation deteriorate, the demand for thermal coal will increase. Alternatively, even if the position should improve, the difficulties and uncertainties in relation to oil created in the 1970s may act against any concerted move back to oil, although some plans to convert from oil to coal firing, particularly in older plants, may be cancelled.

Domestic consumption

Growth in domestic consumption is expected to be considerably slower than in exports. However, it too will be dominated by increased thermal coal use.

The BMR forecast presented here for thermal coal consumption is substantially less than the other estimates shown in the previous table. The reason for this is that the demand as a result of expansion in the aluminium industry is now expected to be less than was previously thought, and growth in other areas will not be sufficient to offset this loss.

The estimates for 1990 exclude any coal that may be used in the production of liquid fuels, because it is considered most unlikely that any significant tonnage will be so utilised by that year. Further, be fore any commitment is made to commercial coal conversion careful consideration must be given to the question whether that process is an optimum use of Australia's coal resources, particularly in view of the country's large resources of oil shale.

Adequacy of resources

All the forecasts presented in Table S suggest strong growth in the Australian coal industry over the next decade. The extent and level of knowledge of Australia's coal resources have been discussed above. The adequacy of those resources to meet the projected growth in the industry must also be considered.

The following discussion on the adequacy of resources must be based on projected raw coal production. For this reason the projections in the previous table, which are for saleable or disposable coal, are converted to raw coal equivalents according to the recovery rate prevailing in 1980 of 82 per cent. Production between now and 1990 will probably be in the order of 1,300 Mt of raw coal. This demand would reduce today's recoverable demonstrated economic resources to 27,432 Mt. Converting the projections given in the previous table to raw coal, using the 1980 average recovery, one may calculate the life of the demonstrated economic resources as follows: for BMR projections. 129 years; for World Coal projections, 121 years and for Joint Coal Board, 119 years (low projection) or 81 years (high projection).

These figures are based on 1981 recoverable demonstrated economic resources an assume no growth in demand after 1990 and no technological changes that would allow increased recovery of coal. Exploration in the next decade will of course continue to elevate inferred and newly discovered resources into the 'demonstrated economic' category and demand after 1990 will most likely continue to grow. The extent to which addition to resources will outstrip increased use or vice versa is unknown, although the situation should be kept in perspective by noting that

between 1975 and 1980 some 522 Mt of raw coal was mined while over 15,500 Mt was added to **in situ** demonstrated economic resources.Consequently, I would suggest that the resource life projections above are minima. However, these 76 figures do not account for possible use of coal for synfuel production. If a decision is taken to use black coal as a feedstock for production of liquid fuels, consumption is going to increase greatly, putting additional strain on the resource.

On the basis it would appear that our present knowledge of Australia's demonstrated black coal resources may be adequate for medium-term use and planning. For longer-term planning and use, i.e beyond 20-30 years considerably more exploration and testing is necessary. The fact that 477,000 Mt of resources is categorised as 'inferred' means that, while such resources may well exist in the tonnages estimated at present, we do not know enough about them to determine if they can be mined economically or if the quality is acceptable to consumers.

A combination of many factors will ultimately determine the rate of growth of the Australian coal each industry. Perhaps the greatest obstacle to achieving the projected growth rates might be the failure to paper customers 10 commit themselves to purchase coal in sufficient time to allow financing and all associated works at mines and ports to be completed. Within Australia obstacles to be overcome will include transport and port facilities of adequate capacity to handle the projected tonnages. Less obvious but of equal importance is the question of availability of trained manpower including miners, mining engineers, and geologists. Continued effort is required to upgrade our knowledge of the coal presently included in the 'inferred resources' category, and to quantify resources about which little is presently known, Despite these reservations, the Australian coal industry seems assured of a bright future.

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